State Exam – Mathematics

Calculus

1. Limits and Continuity
Precise Definition of Limit and Limit Lows. Squeeze Theorem. Intermediate Value Theorem. Extreme Value Theorem

2. Derivatives and Differentiation
Chain Rule. Higher Derivatives. Critical Numbers and Local Extreme Values. Fermat's, Rolle's and Mean Value Theorems. L 'Hospital's Rule. Concavity and Points of Inflection. Curve Sketching: Minimum and Maximum Problems, Asymptotes.

3. Integrals
Riemann Integrals. Antiderivatives and The Fundamental Theorem of Calculus. Techniques of Integration: Substitution Rule, Integration by Parts, and Integration of Rational Functions by Partial Fractions, Rationalizing Substitutions.

4. Applications of Integrals
Areas between Curves. Volumes, Volumes of Revolution. Arc Length. Area of a Surface of Revolution

5. Infinite Sequences and Series
Sequences - monotonic and Bounded Sequences, Subsequences. Series - Test for Divergence, Harmonic Series. Tests for Convergence: Integral Test, Comparison Test, Root and Ratio Tests, Alternating Series. Absolute Convergence.

6. Power Series
Radius and Interval of Convergence. Term-by-term Differentiation and Integration. Expansion of Functions as Power Series - Taylor and Maclaurin Series, Remainder Term.

7. Differential Calculus of Functions of Several Real Variables
Limits and Continuity. Differentiability, Partial Derivatives, Directional Derivatives and Gradient Vector, Chain Rule, Tangent Planes and Differential. Level Sets, Level Curves and Level Surfaces. Maximum and Minimum Values, Lagrange Multipliers. Implicit Function Theorem and Inverse Function Theorem.

8. Multiple Integrals
Definition and General Properties of Multiple Integrals, Iterated Integrals and Fubini's Theorem. Change of Variables in Multiple Integrals, Polar and Spherical Coordinates. Applications - Volumes and Areas.

9. Green's Theorem and Applications. Line Integral along a Parametrized Curve. Path Integrals of Functions and Line Integrals of Vector Fields. Fundamental Theorem for Line Integrals, Simple Curves and Simply Connected Regions, Independence of the Line Integral on Parametrization.

10. Stokes Theorem, Gauss's Theorem and Applications
Curl and Divergence of a Vector Field. Parametrized Surfaces and their Areas. Orientation of a Surface. Surface Integrals Vector Fields.

Ordinary Differential Equations

1. First Order Equations
Existence and Uniqueness Theorem. Separation of Variables, Homogeneous
Equations. Exact Equations, Integrating Factors, Linear Equations, Substitutions.

2. Linear Equations. Existence and Uniqueness Theorem. The Space of Solutions of a Homogeneous Linear Equation - Fundamental Set of Solutions, Wronskian and Linear Independence. Non-homogeneous Equations - Method of Undetermined Coefficients, Variation of Parameters. Euler-Cauchy Equations.

3. The Laplace Transform and Applications,

Linear algebra

1. Vector spaces. Subspaces. Linear independence. Basis and dimension.

2. Linear transformations. Matrices of a linear transformation. Similarity. Kernel and Range. Rank and Nullity. Eigenvalues and eigenvectors. Diagonalization.

3. Inner product spaces. Orthogonal Bases. Gram-Schmidt orthogonalization. .

4. Symmetric, Hermitian and Orthogonal transformations - Diagonalization.

Abstract algebra

1. Groups. Subgroups, cyclic groups. Cosets - Lagrange's theorem. Homomorphism and isomorphism. Normal subgroups and quotient groups. Isomorphism theorems.

2. The symmetric group S_n. Conjugation in the Symmetric group. Finite groups of small order. The free group. Generators and relations.

3. Rings. Subrings. Basic concepts and properties. Integral domains and Fields. Characteristic of a field. Polynomial rings. Euclidean algorithm and greatest common divisor. Irreducible polynomials.

4. Homomorphisms and ideals. Quotient rings. 1^{st} Isomorphism Theorem; Correspondence Theorem.

5. Maximal ideals. Hilbert’s Nullstellensatz.

Complex Analysis

1. Holomorphic functions, Fundamental theorems,
Cauchy's integral, Cauchy's inequalities, Liouville's theorem.

2. Taylor and Laurent's expansions

3. Residue theorem and applications.
Evaluation of real integrals by the method of residues.

Numerical analysis

1. Solutions of Equations in one Variable Iterative Methods and Error Analysis

2. Interpolation and Polynomial Approximation Lagrange, Hermite Interpolations and Cubic Spline Approximation

3. Numerical Differentiation and Integration
Gaussian Quadrature. Multiple and Improper Integrals

4. Initial-Value Problems for Ordinary Differential Equations Euler's Method, Runge- Kutta Methods

Statistics

1. The probability set function. Conditional probabilities and independence.

2. Random variables of discrete and continuous type. Expectations. Chebyshev's inequality.

3. Some important probability distributions: Binomial, Poisson, Multinomial, Gamma, Chi-square and Normal distributions.

4. Limiting moment-generating functions and the central limit theorem.

5. Sampling theory. Confidence intervals for means. Concepts of statistical Hypotheses testing.

State exam: References

Calculus

1. J. Stewart, Calculus, 7th ed. Brooks/Cole Publishing, 2012

Differential Equations

2. E. D. Rainville, Ph. E. R. Bedient, E. Bedient, Elementary Differential Equations, Prentice Hall, 1997. The book is on reserve at the AUBG Library.

Linear Algebra

3. David C. Lay, Linear Algebra and its Applications , 4th edition, Pearson International, 2012
4. Gilbert Strang, Linear Algebra and its Applications , 4th edition, Cengage, 2006
5. S. Lang, Linear Algebra, 3rd ed. Springer-Verlag, 2010

Abstract Algebra

6. Michael Artin, Algebra, 2nd edition, Prentice Hall, 2011
7. Joseph Gallian, Contemporary Abstract Algebra, 8th edition, Cengage, 2013

Complex Analysis

8. Theodore W. Gamelin, Complex analysis, Undergraduate Texts in Mathematics. New York, NY: Springer. xvi, 478 p., 2001
9. Zill Shanahan, A First Course in Complex Analysis with Application, Jones & Bartlet, 2010

Numerical Analysis

10. R. Burden, J Faires, Numerical Analysis, , 9th edition, Cengage 2011

Statistics

11. R. V. Hogg and A. T. Craig, An Introduction to Mathematical Statistics, 5th edition, Prentice Hall, New York, 1995. The book is on reserve at the AUBG Library
12. R. V. Hogg, A. T. Craig, and Mac Kean, An Introduction to Mathematical Statistics, Pearson, 2014
13. W. Mendenhall, R. Beaver and B. Beaver, Introduction to Probability and Statistics, 14th edition, Cengage, 2013